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CONTENTS

1 Introduction 4
2 Normative and Informative documents 4
2.1 Normative Documents 4
2.2 Informative Documents 4
3 Abbreviations 5
4 Electrical Interfaces 6
4.1 Science Unit Connector Definition 6
4.2 Grounding 6
4.3 EMC requirements 7
4.4 Power Budget 7
5 Command and control interface 7
5.1 Data Handling and Control 7
5.2 Telemetry and Telecommands 7
5.2.1 Telemetry 7
5.2.2 Telecommands 8
5.3 RDY Flag 8
5.4 Example Sequence Table 8
6 Mechanical interface 8
6.1 Accommodation and Field of View 8
6.2 Interface control drawing 8
6.3 Surface finish 9
6.4 Mass 9
7 Attitude Control 9
8 Cleanliness and Contamination 9
9 Operating Conditions 9
10 Handling 9
11 Thermal 9
12 Appendix 1 11

1 Introduction

This document controls the required interfaces between a QB50 CubeSat and a QB50 Science Unit.

Science Unit: As described in the call for proposals, the menu of sensors selected for the science units is:

- Ion Mass Spectrometer (IMS)
- Neutral Mass Spectrometer (NMS)
- Flux-Φ-Probe Experiment (FIPEX)
- Multi-Needle Langmuir Probe (MNLP)
- Corner Cube Laser Retroreflectors (CCR)
- Thermistors/thermocouples/RTD (TH)

A Science Unit will comprise a subset of the above list. The design objective for the Science Unit is to remain within a 600 mW power budget (duty-cycled, orbit averaged), 600 g mass budget and half a CubeSat unit volume budget (excluding forward protuberance). 20% design margin is being held within these budgets. As the final configuration of the Science Unit to be provided to each of the CubeSat teams will only be made known after selection, representative mechanical and electrical interfaces with an overall resource envelope of the design objective are provided here.

The location and interface of Thermistors within the body of the CubeSat will be included in a later version of this document.

The location and interface of the Corner Cubes, if selected, will be included in a later version of this document.

2 Normative and Informative documents

2.1 Normative Documents

ND1: UM-3: CubeSat Kit User manual Rev D2 issued 17 Sep 2003.

2.2 Informative Documents

ID1: Call for CubeSat Proposals for QB50 issued 15 Feb 2012

ID2: QB50 SSWG Final Report to be issued 1 Mar 2012

3 Abbreviations

ADC	Analogue to Digital Converter
CEM	Channel Electron Multiplier
DAC	Digital to Analogue Converter
EGSE	Electronic Ground Support Equipment
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ESD	Electro-Static Discharge
FMMU	Flash Mass Memory Unit
FPGA	Field Programmable Gate Array
HSDR	High Speed Data Recorder
HV	High Voltage
I/F	Interface
IMS	Ion Mass Spectrometer
kbps	kilo bits per second
LEO	Low Earth Orbit
LV	Low Voltage
LVDS	Low Voltage Differential Signalling
MSSL	Mullard Space Science Laboratory
NMS	Neutral Mass Spectrometer
PCB	Printed Circuit Board
PWM	Pulse Width Modulator
S/C	Spacecraft
SEE	Single Event Effects
SMD	Surface Mount Device
SPI	Serial Peripheral Interface
TBC	To be confirmed
TBD	To be decided
TBI	To be included

4 Electrical Interfaces

There will be a single electrical connector between a Science Unit and a CubeSat. The Science Unit shall provide an MDM15-male connector for the CUBESAT side harness to attach to. The CubeSat shall provide power, clock, the I2C interface bus and a single bit port (RDY) signal as shown below.

4.1 Science Unit Connector Definition

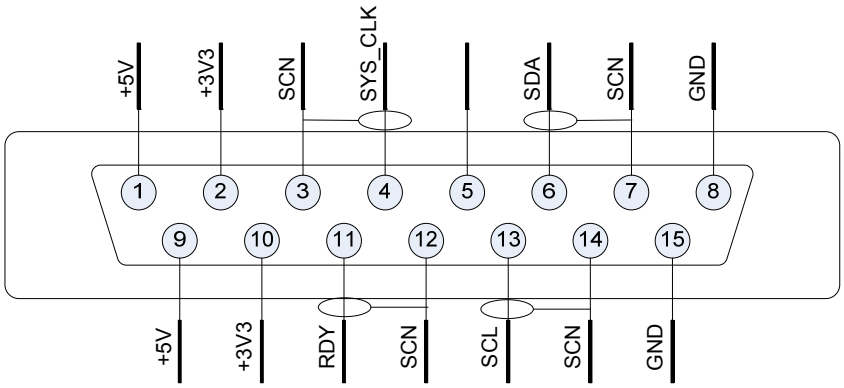

Figure 4-1 Connector Pin-Out Diagram

Pin	Signal Name	Comment
1	+5	Power for +5V logic
2	+3V3	Power for +3V3 logic
3	SCN	Screen for SYS_CLK
4	SYS_CLK	7.4 MHZ (TBC) S/C system clock
5	-	Not used
6	SDA	I2C serial data signal
7	SCN	Screen for SDA
8	GND	System GROUND
9	+5	Power for +5V logic
10	+3V3	Power for +3V3 logic
11	RDY	This may connect to any available INPUT port pin on the S/C processor.
12	SCN	Screen for RDY
13	SCL	I2C serial clock signal (100 kHz)
14	SCN	Screen for SCL
15	GND	System GROUND

Table 4-1 Instrument Connector Pin Assignment

The +5, +3V3 and the GND connections are duplicated to provide redundancy in the harness.

4.2 Grounding

The Science Unit electronics shall be electrically grounded to the CubeSat structure via GND. The Science Unit Chassis is electrically connected to the CubeSat structure at its points of attachment. The electrical resistance shall be <50 mΩ.

4.3 EMC requirements

TBI

4.4 Power Budget

The power budget is shown in Table 4-2. These numbers are preliminary TBC and include the 20% design margin.

Mode	Power at +5V (mW)		Power at +3.3V (mW)	
	Orbit average	Peak	Orbit average	Peak
Standby	3	279	1	100
Science Mode	499	640	77	100

Table 4-2 Power Budget

5 Command and control interface

5.1 Data Handling and Control

The I2C interface shall be used to control the instrument from the CubeSat.

The I/F shall nominally operate at 100 kHz clock speed.

The Science Unit is treated as a device on the I2C bus. It shall have a fixed address, set within the Science Unit.

A buffer (size TBD) shall be provided in the Science Unit to store the science data & associated parameters.

Data shall be transmitted from the Science Unit to the CubeSat computer over the I2C interface on command from the CubeSat computer.

5.2 Telemetry and Telecommands

5.2.1 Telemetry

The following telemetry packets shall be issued by the Science Unit to the CubeSat:-

Telemetry Packet
Science Packet
House-Keeping Packet
Engineering Packets

Table 5-1 Telemetry

The packet formats shall follow the I2C protocol and will be provided in a subsequent release of the ICD.

5.2.2 Telecommands

Telecommands will be issued by the CubeSat to the Science Unit according to the science operations plan being executed. Command sequences from ground shall be time-tagged. The Science Unit will execute commands immediately upon receipt.

5.3 RDY Flag

The Science Unit shall provide a RDY level sensitive flag signal to indicate when the SCIENCE DATA are available.

The CubeSat computer shall monitor the RDY bit to determine when to perform a Science Packet read operation. The packets must be time-stamped by the CubeSat within 1s of the packet generation.

5.4 Example Sequence Table

Below is given a pseudo sequence example of how the Science Unit would be run.

There may be several (TBD) sequences uploaded and stored in CubeSat memory, which would be run at predefined times (i.e. time-tagged).

Command	Time	Comment
SU_ON	t0	Turn ON power to Science Unit; Unit will go to Standby
RUN_SCIENCE	t1	Science Unit operational mode.
STDBY	t2	Go to Standby mode.
SU_OFF	t3	Turn OFF power to Science Unit

Table 5-2 Example Sequence Table

6 Mechanical interface

6.1 Accommodation and Field of View

The Science Unit will be accommodated at one end of the CubeSat, on a 10 x 10 face. The vector normal to this face shall be in the spacecraft ram velocity direction. This face shall not be available for Solar cells, any other sensor or subsystem and nothing must project forward of this face.

6.2 Interface control drawing

The mechanical interface drawing is provided in Appendix 1. The Science Unit is designed to interface to commercially available CubeSat structures either through an adapter or through appropriate relocation of mounting holes on the structures.

6.3 Surface finish

The overall finish for the Aluminium structure of the Science Unit shall be Alocrom 1200.

6.4 Mass

The total Science Unit mass shall be < 600 grams.

7 Attitude Control

The CubeSat shall provide attitude control with a pointing accuracy of +/-10° and pointing knowledge of +/-2° (TBC).

8 Cleanliness and Contamination

The CubeSats shall maintain an ambient pressure due to outgassing of < $5x10^{-6}$ mb.

9 Operating Conditions

The particular operating conditions will depend upon the selection of sensors for a given Science Unit. These will be made known at the time of selection.

10 Handling

The Science Unit shall be handled in a cleanroom environment (details TBI).

ESD protection protocols shall be followed (details TBI).

11 Thermal

At least one thermal sensor will be used to monitor the temperature inside the CubeSat enclosure. This will be in addition to the thermistors in the Science Unit which are used for scientific measurement.

Item	Science Unit
Operational Temperature Range	-20°C to +40°C (TBC)
Non-Operational Temperature Range	-30°C to 65°C (TBC)
Minimum Standby temperature	-25°C (TBC)

Figure 11-1 Thermal operating requirements

Item	Science Unit
Thermal capacity	TBD J/K
Radiative properties	Alpha = TBD epsilon = TBD
Contact area	TBD mm²
I/F conductance	TBD W/m^2K
Thermal interface filler	TBD

Figure 11-2 Thermal properties

12 Appendix 1

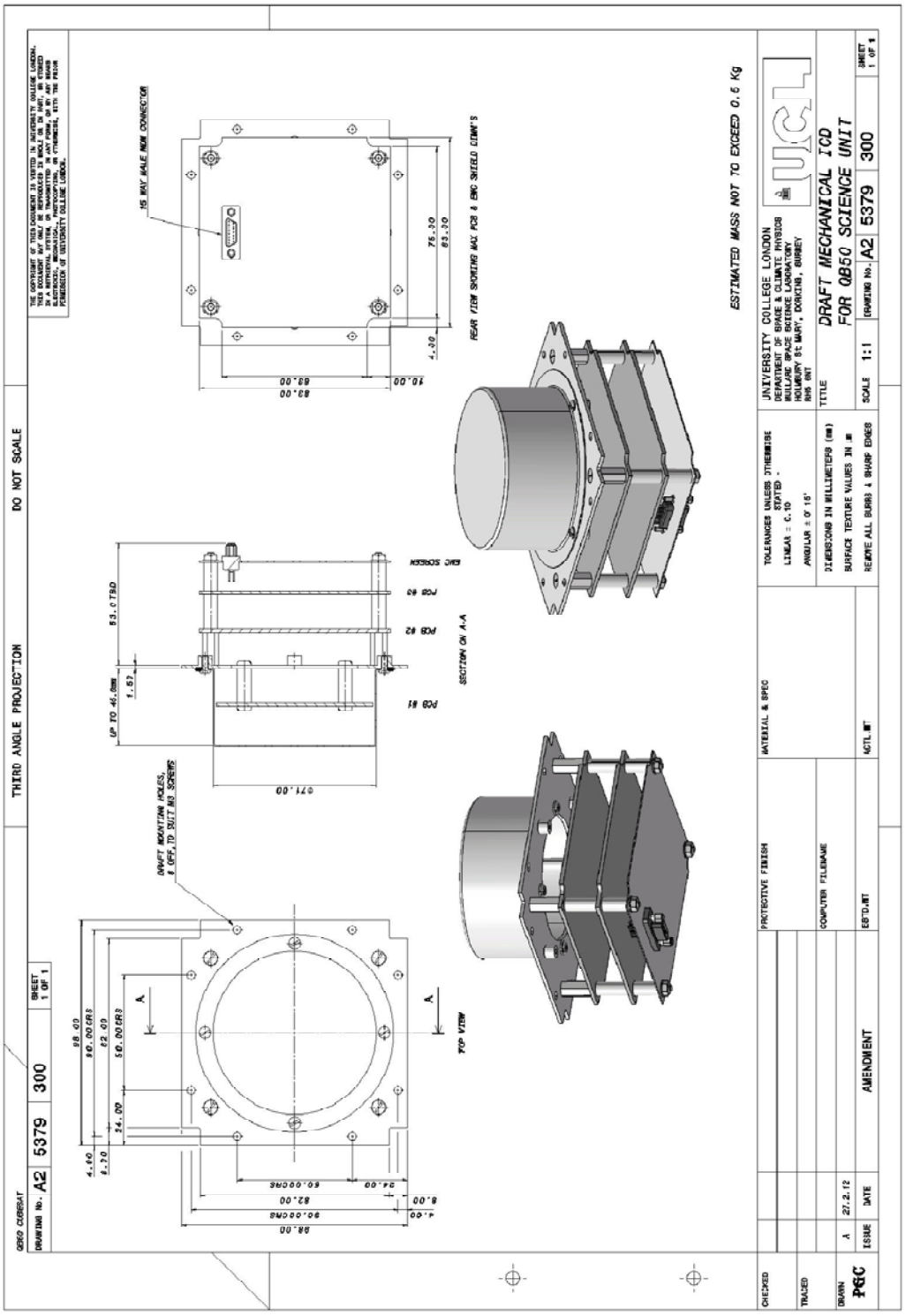
ESTIMATED MASS NOT TO EXCEED 0.6 Kg
UNIVERSITY COLLEGE LONDON
DRAFT MECHANICAL ICD
FOR QB50 SCIENCE UNIT
DRAWING No. A2 5379 300
SCALE 1:1
THIRD ANGLE PROJECTION
DO NOT SCALE
REAR VIEW SHOWING WAY FOR 8 END SHIELD DIM'S
SECTION ON A-A
TOP VIEW
DRAFT MOUNTING HOLES, 8 OFF, TO SUIT M3 SCREWS

Figure 12-1 QB50 Science Unit Mechanical Interface Drawing